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THE NORTHWARD EXTENSION OF THE PHYSIOGRAPHIC DIVISIONS OF THE UNITED STATES

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PART II

THE GREAT PLAINS PROVINCE

East of the Rocky Mountain System lies a plateau area that slopes gently away from the mountains. Custom has firmly attached to the part of this region lying within the United States the name of "Great Plains." In the present paper this name will be used to include the Canadian and Alaskan sections of the province.

The Great Plains extend uninterruptedly from the Pecos and Rio Grande rivers northward through the United States[1] and Canada to the shores of Great Bear Lake.[2] At this place the Mesozoic and Tertiary rocks of the Great Plains Plateau are cut off by a westward extension of the pre-Cambrian rocks of the great Laurentian Plateau and the province becomes restricted to a narrow belt. However, it widens again near the boundary between the Northwest Territories and Alaska, and gradually develops into the Anatuvuk Plateau of Alaska which has a width of about 150 miles. This section of the province terminates near the one hundred and sixty-third meridian, where its mountainous southern boundary closes with the Arctic shore line.[3] As shown on the accompanying map the northern part of the province bends to the west in conformity with the general trend of the neighboring Cordillera.

The western boundary of the province throughout its entire extent is the Rocky Mountain System. These two divisions are sharply distinguished topographically. On the east the province is generally satisfactorily delimited. It is separated from the Central Lowland for considerable distances by an eastward facing escarpment from 200 to 1,000 feet high. The most conspicuous portion of this escarpment (the Missouri coteau) begins near the southern boundary of North Dakota and extends northward to about the fifty-fourth parallel.[1] Beyond this to the vicinity of

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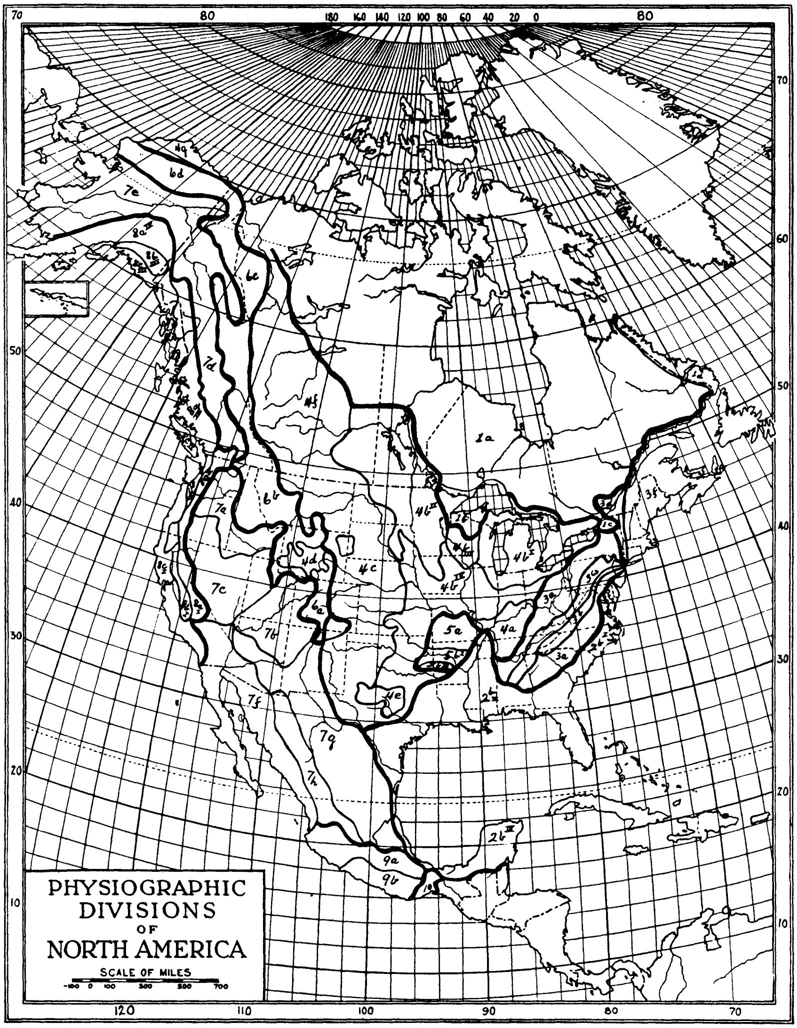
[1] N. M. Fenneman, *Ann. Assoc. Am. Geog.*, IV, pl. 1.

[2] C. A. Young, *Geol. Survey Canada, Pub. 1085*, p. 107.

[3] A. H. Brooks, *U.S. Geol. Survey, Prof. Paper 45*, pp. 46, 47.



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[1] C. A. Young, *loc. cit.*

Great Bear Lake the boundary is essentially the contact of Mesozoic and younger sediments on the west with old pre-Cambrian rocks on the east. In the Anatuvuk Plateau section, the contact of Mesozoic and Tertiary rocks on the south with later Tertiary sediments of the Arctic Coastal Plain on the north may be regarded as the boundary line. This line is not easy to recognize everywhere in the field. In many places the merging of plain and plateau is imperceptible; in other places the coastal plain is wanting and the waves of the Arctic Ocean dash against the base of the plateau scarp.[1]

Many of the features of the Great Plains in the northern part of the United States owe their origin and character either to base-leveling or glacial accumulation, or to both. In brief, the topography may be described as a broad expanse of moderately rolling plateau broken here and there by valleys and irregularly dissected tracts, and rising westward to the foot of the Rocky Mountains at a rate of four or five feet to the mile. Standing above the general surface are a few residuals that resisted the Tertiary base-leveling. Turtle Mountain near the boundary of North Dakota and Manitoba is typical of these. Glacial moraines with their accompanying bowlder ridges, lakes, and ponds are characteristic.

Approximately the same conditions are continued northward into Canada to about the fifty-fourth parallel. The topography of this section is also irregular and rolling. The plateau surface rises from 2,000 or 2,500 feet at the eastern escarpment to about 4,000 feet, where it meets the mountains on the west. Residual masses, such as the Cypress Hills and Wood Mountain, represent the resistant and unreduced portions of a once higher plain.[2] The numerous ponds and lakes scattered over the surface are glacial features.

The Anatuvuk Plateau of Alaska is also a dissected peneplain (Eocene or Miocene) which has been elevated to an altitude of about 2,500 feet at the northern base of the Endicott Mountains, from which elevation it descends gradually to about 800 feet, where it merges with, or overlooks, the Arctic Coastal Plain.[3]

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[1] A. H. Brooks, *loc. cit.*

[2] C. A. Young, *op. cit.*, p. 107.

[3] A. H. Brooks, *op. cit.*, pp. 279, 280.

Structurally the Great Plains are a unit from Texas to Alaska. Although the strata of the divisions within the United States lie sensibly flat for short distances, the structure of the bedrock (Paleozoic or Mesozoic sediments) has the general character of a great geosyncline which rises sharply on approach to the Rocky Mountains, where the steeply inclined eastward dipping strata appear in the form of "hogback" ridges fringing the Front Ranges of the Rocky Mountains. A *regional* westward dip of the plains strata is general for the province, but it is modified locally by structural deformations of some importance. The eastern outcrop of the westward dipping strata is marked by the escarpment and coteaus previously referred to.

Similar structural features exist in Canada[1] and on the whole in Alaska, though on the Anatuvuk Plateau the Mesozoic strata appear to have been thrown into a series of broad, open folds, and even the early Tertiary deposits have been subjected to minor deformation.[2]

In early Tertiary time the Great Plains of the United States were raised out of the sea and have remained a land surface ever since. The Tertiary period was one of active erosion, and during that time the region was base-leveled, excepting the residuals previously cited. The western part of the province had the greater initial uplift, consequently it was susceptible to greater erosion. All strata were beveled regardless of changing dip and hardness. Another great uplift in late Tertiary time began the present erosion cycle. In both the United States and Canada this later erosion has caused deep dissection in the western parts of the Great Plains and has almost base-leveled again the low plains to the east.

In Alaska the base-leveling of the Anatuvuk Plateau is assigned to the late Eocene or the Miocene epoch,[3] and the unconsolidated deposits which overlie the eroded strata are supposed to be of Pliocene age. If this time is correct these deposits correlate closely in age with the terrestrial deposits that are so widely scattered over the Great Plains of the United States.

[1] C. A. Young, *op. cit.*, pp. 108–13.

[2] A. H. Brooks, *op. cit.*, pp. 278–80.

[3] A. H. Brooks, *ibid.*

THE WESTERN LAKE SECTION OF THE CENTRAL LOWLAND PROVINCE

East of the Great Plains province lies another plains region that is distinctly lower than the first. Various names have been applied to it, but none seems better adapted to the region as a whole or more inclusive of the several topographically diverse subdivisions than the name used herewith—Central Lowlands. It is subdivided into several sections, but only the two that have Canadian extensions will be discussed in this paper. The first of these is the Western Lake section.

This section is irregular in shape and embraces a large part of the northern interior of the United States and a smaller part of south-central Canada. Its western boundary is the Tertiary erosion scarp (Missouri coteau) previously mentioned. The eastern boundary is also marked by a prominent topographic break throughout most of its length, and where a topographic separation is not easily made from the province next to the east there are good reasons for drawing the line empirically. The eastern boundary begins near Stillwater, Minnesota, and runs northwestward, skirting the Superior Highlands to Rainy Lake. From this point it continues north and west close to the eastern shore of Lake Winnipeg to a point near longitude 102°W. and latitude 55°N., where it closes with the western boundary. This line with minor exceptions is essentially the contact of pre-Cambrian rocks of the Laurentian Plateau with the lacustrine sediments of glacial Lake Agassiz.

An optional line might be run along the most prominent western beach of Lake Agassiz and continued along a series of water-worn cliffs of Cretaceous rock overlooking a region of Silurian bedrock and the alluvial sediments of the former lake. Collectively these cliffs are known as the Manitoba escarpment.[1] Eastward flowing streams have cut numerous deep valleys in this escarpment and have left the intervening remnants standing as isolated hills, the most prominent of which are the Pembina, Riding, Duck, and Porcupine mountains.[2] Beyond Porcupine Mountain there are no adequate data for drawing the line, and it might therefore be placed arbitrarily at the contact of Cretaceous rocks on the west with Silurian rocks on the east, which is essentially the condition existing all along this boundary in Canada, if we neglect the vertical separation of the two systems of rocks at the escarpment. As thus drawn the line curves to the west and closes with the western boundary just north of the fifty-fourth parallel. This line has not been used on the accompanying map because it is desired to correlate this work as closely as possible with the most recent work on the physiographic divisions of the United States.[1]

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[1] C. A. Young, *op. cit.*, p. 108.

[2] D. B. Dowling, *Geol. Survey Canada, Guide Book, No. 8*, Part I, p. 80.

The surface of this region consists largely of a monotonous flat plain covered by the deposits of glacial Lake Agassiz, which at its maximum extended from the latitude of the southern boundary of North Dakota to the northern boundary of Manitoba. The Winnipeg Lake System is a remnant of this great lake. Morainic ridges along the edges of till sheets, intermorainic tracts of rolling till plain, and level lacustrine tracts marking the sites of smaller glacial lakes are also prominent features. The topography may be described in summary as pre-eminently glacial, and the effects of the ice sheets are evident to even the most casual observer.[2]

Similar topographic conditions are found in the Canadian division. Here also the surface is gently undulating and everywhere covered by a veneer of drift which either obscures or accentuates an earlier relief. In southwestern Saskatchewan is the level floor of glacial Lake Saskatchewan, a large and probably short-lived contemporary of the smaller glacial lakes of the United States, such as Souris and Dakota. The valley of the Qu'Appelle, which is one of the several deep valleys cut during postglacial erosion intervals, marks the former course of the South Saskatchewan at the time when the northward flow of that stream was blocked by ice. It is analogous in several ways to the Missouri River.[3]

Though the present relief of this section is pre-eminently of glacial origin, it is really a product of both glaciation and preglacial erosion, and to a lesser extent of postglacial erosion. This region as well as the Great Plains to the west was probably peneplained, or at least subdued, in late Tertiary time. It was later uplifted and well dissected probably in a preglacial stage of the Pleistocene epoch. The driftless area of Wisconsin is generally assumed to represent a slightly modified form of the topography of that stage. Then followed the advances and retreats of four or more ice sheets, with the consequent modification of relief and drainage lines. Since the older drift was deposited, erosion has produced a complex system of valleys in places, and some of the larger streams have developed broad, flat bottoms. In the area covered by the later ice sheets, there has been but little modification of the glacial topography. The rivers have terraced the outwash deposits, but the majority of glacial features remain unchanged. In the Canadian division of this section the drainage lines are still badly disorganized.

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[1] N. M. Fenneman, *Ann. Assoc. Am. Geog.*, VI, pl. 1.

[2] J. E. Todd, *U.S. Geol. Survey, Bull. 144.*

[3] D. B. Dowling, *op. cit.*, p. 80.

THE EASTERN LAKE SECTION OF THE CENTRAL LOWLAND PROVINCE

This is a region of general plain aspect immediately adjacent to the Great Lakes. It is difficult to give an exact definition of it that is inclusive in a broad way of all its topographic features, and at the same time delimit it from neighboring regions of apparently similar features. Writers on the physiography of the United States generally agree that the region adjacent to the Great Lakes possesses distinct glacial features which are easily recognizable from whatever point of the compass it is approached; and although the adjoining areas to the north, south, and west were also glaciated, there is sufficient contrast between the morainic, marshy, lake-dotted surface that characterizes the Lake Region, and the *roche moutoné* surface of the Laurentian Plateau and the till sheets of the plains to the west and south, to justify making this region a separate section.

Within the United States this section is bordered by the Adirondack Mountains, the Allegheny Plateau, the till plains, the Wisconsin driftless area, and the Superior Highlands. This boundary is generally marked by topographic breaks. In places along the border of the Adirondacks the break consists of the contrasting topography of mountain and plain; along the edge of the Allegheny Plateau it is an erosion scarp; in still other places it is a difference in topography not always to be comprehended in a single view, but none the less real on that account—the difference between a surface of morainic ridges and till sheets. The northern boundary begins near Fort William, Ontario, and in a general way follows the shore line of the Great Lakes to the vicinity of Kingston, Ontario, where it closes with the eastern and southern boundary. This boundary is placed at the contact of the pre-Cambrian bedrock of the Laurentian Plateau and the sediments of the glacial lakes. As drawn on the accompanying map it practically coincides with the Algonquin-Iroquois beach as mapped by Upham,[1] and Leverett and Taylor.[2]

This section has two well-defined types of topography. The first consists of lacustrine plains immediately surrounding the existing lakes and bounded in places by morainic ridges concentric with respect to them. These "lake plains" are built up of the sediments of glacial lakes that covered an area greater than the present lakes. They are in topography, age, and structure analogous to the lacustrine plains of the Western Lake region. A narrow strip of territory of this type extends around to the Canadian side of the Great Lakes.

The second type of topography embraces areas characterized by ground moraine, morainic ridges, swamps, and small lakes. These areas border the "lake plains" on the south and constitute by far the larger part of the section. Similar topographic features are found north of the Great Lakes, in fact, they are widely scattered over the Laurentian Plateau, but they are so decidedly subordinate to the features of the old erosion surface that no great difficulty is experienced in locating the dividing line between the two provinces. This second type of topography is particularly well developed in the peninsular portion of Ontario.[3]

Glaciation is of course the main topic to be discussed in the physiographic history of this section. All of the principal features of the topography are the results either of unequal glacial accumulation or of the alteration of drainage lines; and although preglacial topography probably conditioned results to some extent, it is now so nearly obliterated that history must begin with the surface changes of the Pleistocene epoch. These were the changes incident to the advance and retreat of several ice sheets. The United States and Canadian divisions of the section were similarly and contemporaneously affected. Post-Pleistocene history is largely a record of drainage readjustments following the final disappearance of the ice.

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[1] Warren Upham, *U.S. Geol. Survey, Mon. 55.*

[2] Frank Leverett and F. B. Taylor, *U.S. Geol. Survey, Mon. 53.*

[3] F. B. Taylor, *Geol. Survey Canada, Summary Report* (1909), pp. 164–67.

THE NEW ENGLAND PROVINCE

East of the Hudson-Champlain Valley and south of the St. Lawrence River lies the New England region. Physiographers regard it as a province in the major division of the Appalachian Highlands. It is bounded on the east by the Atlantic Ocean, and on the west by a line running north from Long Island Sound along the eastern border of the Hudson-Champlain Valley[1] to the foot of Lake Champlain, thence northeast to the city of Quebec and down the St. Lawrence Valley.[2] Newfoundland, though detached and separated from the mainland by a considerable body of water, is really an outlier of this province and will be treated as a section of it.

Exclusive of the coastal margin, New England topography is largely of the type of an uplifted, extensively dissected, and glaciated peneplain. To this general characterization, however, must be added certain modifications. Although the terms "upland" and "plateau" may be properly applied to the southern half, a part of the northern half is so mountainous as quite to conceal the plateau feature. The Connecticut Valley must also be considered as departing from the general characterization. The topography is controlled by three prominent structural features, namely: (1) a western mountain axis, extending through Connecticut, Massachusetts, and Vermont; (2) an eastern mountain axis, unimportant topographically in the United States, which runs from Rhode Island to the Maritime Provinces of Canada; and (3) a long, narrow, structural depression between these two axes, in part occupied by the Connecticut Valley.

Each of these mountain axes was early in geologic time a line of elevation. The northern part of each still retains the mountainous character of the initial (or at least an early) uplift, but the southern parts were eroded to the condition of a peneplain, then elevated again and dissected.[1] Standing above the general surface of the uplifted peneplain are numerous residual mountain masses or peaks, typical of which are Monadnock and Katahdin.[2]

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[1] N. M. Fenneman, *Ann. Asso. Am. Geog.*, IV, 101–4.

[2] C. A. Young, *op. cit.*, p. 108.

The Connecticut Valley, though a structural as well as a topographic depression throughout its entire length, also has northern and southern divisions of unlike characteristics. In this case, however, the contrast is not due so much to differential uplift or depression as to inequalities of hardness and resistance to erosion.

The general conditions just cited for New England are continued across the International Boundary into Canada. The Green Mountains of Vermont, the northern expression of the western axis, extend into Quebec under the name of the Notre Dame Mountains. They border the estuary of the St. Lawrence and continue into and through the Gaspé Peninsula, where they are known as the Shickshocks. The White Mountains of New Hampshire, the northern expression of the eastern axis, extend northeastwardly through Maine, close to the border of Quebec, and gradually blend with the elevated tracts of New Brunswick and the Maritime Provinces. "Though the general course of the hills of the Maritime Provinces parallels that of the Appalachians, the propriety of including the territory in the Appalachian region is better shown by the geologic features, such as the Appalachian folding, and by the pronounced northeastwardly trend of the whole Province of Nova Scotia, the parallel long indentation of the Bay of Fundy in the southeast and that of Chaleur Bay with the valley at its head in the northwest."[3]

The Appalachian part of Canada is generally regarded as having participated in the Jurassic-Cretaceous base-leveling, and locally at least in the Tertiary base-leveling. The accordance of summit elevations, particularly in the eastern portion, and the presence of isolated residuals rising here and there above the upland level indicate a former peneplain which probably correlates with the higher peneplain of the Appalachians in the United States. Sutton Mountain of the Notre Dames and many of the peaks on the Gaspé Peninsula are typical monadnocks. The Cobequid upland of Nova Scotia is compared by Bell[1] to the Unakas and its origin referred to the Cretaceous base-leveling, and the Cumberland lowland adjoining it is regarded by him as a local peneplain developed in Tertiary time.

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[1] W. M. Davis, *Bull. Geol., Soc. Am.*, II, 557.

[2] J. H. Perry, *Jour. Geol.*, XII, 1–14.

[3] C. A. Young, *op. cit.*, pp. 30–32.

Though cut off from the mainland, Newfoundland is really a structural and topographic subdivision of the Appalachian region. The uplands of Newfoundland are the remnants left by the dissection of a once almost perfect peneplain, and there is no more striking feature in its topography than the marked parallelism of its peninsulas, re-entrants, lakes, ridges, rivers, and outcrops, which in nearly every case approximates a direction of N.20°E.[2] The Shickshocks of the Gaspé Peninsula, after being interrupted by the depression of the St. Lawrence Valley, seem to be continued in the Long Range, a mountainous feature that parallels the entire western coast of Newfoundland. This range has an average elevation of about 2,000 feet and compares very closely in this respect with the Shickshocks. The Lewis Hills, apparently a residual mass lying half-way between St. George Bay and the Bay of Islands, rise to 2,700 feet. The elevated tracts of the Maritime Provinces also appear to be continued beyond the Gulf of St. Lawrence in a series of flat-topped hills, on which rise local elevations separated by long, parallel valleys.

On the side of the island that faces the gulf the youthful aspect of the streams, the numerous terraces rising like gigantic steps from 12 to 400 feet above high water, and the delta deposits at the mouths of the rivers indicate several recent stages of elevation; but on the seaward side drowned gorges and almost submerged islands testify to recent and progressive submergence. These conditions are suggestive of the conditions existing between northern and southern New England with respect to elevation and depression. Clark,[3] however, connects Newfoundland orogenically with the mainland only through the eastern axis, and he states that the western axis ends in an arc at the end of the Gaspé Peninsula.

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[1] W. A. Bell, *Geol. Survey Canada, Guide Book, No. 1*, Part II, pp. 326–28.

[2] W. H. Twenhofel, *Am. Jour. Sci.*, Fourth Series, XXXIII, 1–24.

[3] J. M. Clark, *Geol. Survey Canada, Guide Book, No. 1*, Part I, pp. 93–95.

The physiographic history of the New England region begins with the close folding that occurred near the end of the Pennsylvanian epoch. But although this folding controls the topography, the detailed forms so far as known are the net result of two periods of base-leveling and subsequent uplift, one in Jurassic-Cretaceous and the other in Tertiary time, modified by glaciation.

Of the history of the Canadian Appalachians, Goldthwait[1] says:

> During the closing part of the Mesozoic subaërial denudation seems to have held sway. The mountains were slowly but surely reduced to a plain of low relief or "peneplain." Locally, in districts remote from the coast and where stronger rock structure appeared just above the Cretaceous base-level, the reduction of the surface was incomplete and many residual mountains or monadnocks were left. On the whole, however, the base-leveling was very thorough, planing away the harder rocks as well as the weaker.
>
> This almost complete cycle of denudation was brought to a close at about the beginning of the Tertiary by regional uplift. The uplift seems everywhere to have been greatest in the interior and least near the coast. By it the seaward-flowing rivers were revived and a new cycle of erosion was begun, and by mid-Tertiary time broad lowlands had been developed. Another uplift occurred and the lowlands were carved by the streams until a fairly mature topography had been evolved beneath the Tertiary surface.

THE LAURENTIAN PLATEAU

Lying with its vertex near the Great Lakes a U-shaped area of pre-Cambrian rocks stretches away to the north, inclosing Hudson Bay in its arms, and extends into the still unexplored regions of the Arctic. It embraces nearly all of the northeastern part of North America and projects two spurs, the Adirondack Mountains and the Superior Highlands, into the United States.

The western and southern boundaries of this division have been described or have had their locations implied in previous paragraphs. The location of the northern boundary cannot be stated with accuracy, but may be placed tentatively near the sixty-eighth parallel. The northeastern boundary of the plateau proper is a group of mountains that lie close to the coast and extend from the

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[1] J. W. Goldthwait, *Geol. Survey Canada, Guide Book, No. 1*, Part I, pp. 6–7.

Straits of Belle Isle northward through Labrador, Baffin Island, Devon Island, and Ellesmere Island to Cape Sabine, a distance of approximately 2,000 miles. The ranges of this group are truly mountainous, with known elevations of 6,000 feet or more and with peaks estimated to approach 7,500 feet.[1] Allowing even a wide latitude of topographic variation, such mountains could scarcely be considered an integral part of the plateau. In the absence of topographic data the line separating plateau from mountains can be conjectured only, and that within wide limits of error. From the Straits of Belle Isle the southwestern boundary is the Gulf of St. Lawrence and the estuary of St. Lawrence River. Within these boundaries the Laurentian Plateau may be considered to be a topographic unit. Its chief features are those of a peneplained region of crystalline rocks which was uplifted, extensively dissected by ordinary erosion processes in preglacial time, and more recently heavily glaciated.

The Laurentian Plateau has a gently undulating surface, diversified by such glacial features as moraines, lakes, swamps, muskegs, and outwash deposits. Over large areas a hill 150 feet high is a conspicuous feature of the topography, and though a few do actually approach 300 feet, they are of course residuals. The plateau is generally considered to be an uplifted peneplain, dissected to such a degree that it appears rough but not rugged. It should be borne in mind, however, as Adams[2] has pointed out, that the term peneplain is used merely as descriptive of the nearly level character of the country without any implication for a definite origin for it. Wilson[3] has called attention to the fact that it is not a single peneplain, but probably a series of facets produced in widely separated periods. Very few of the qualities of the typical peneplain are present. There are no deep residual soils; in fact, there is no continuous cover of soil, except in the southern part, and no well-organized drainage courses. Instead there is a maze of youthful streams and lakes, and in places the altitude reaches 2,000 feet. Unequal uplift and intense glaciation have so modified the topography that must have existed at the end of the erosion interval preceding the glacial epoch as to make its general peneplain character recognizable only by the pronounced and uniform discordance between surface and geologic structure.

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[1] F. D. Adams in *Problems of American Geology* (Yale University), p. 45.

[2] F. D. Adams, *op. cit.*, p. 49.

[3] A. W. G. Wilson, *Jour. Geol.*, XI, 615–19.

The southeastern border of the plateau, where it overlooks the St. Lawrence lowlands and the estuary of the St. Lawrence River, is more rugged and uneven than the remainder, and is known as the Laurentide Mountains. The greater ruggedness of this border is due not entirely to residuals that survived the base-leveling of earlier cycles, but to some extent at least to the greater uplift of the peneplain along this line. An observer on the highlands looks across a plateau-like surface, but one in the lowlands looks up against the scarplike face of a range of hills of sufficient height to be known as mountains. It has been suggested that this escarpment may mark the line of a fault or a series of faults.[1]

Tributaries of the St. Lawrence cross the Laurentide Mountains in deep, steep-sided canyons or gorges, which accentuate the ruggedness of the local topography. The Saguenay, the Coldwater, the Hamilton, and the Ottawa rivers are typical of this class, and in places their canyons are more than 2,000 feet deep. These canyons may represent ancient river valleys deepened by subsequent glaciation, or they may be of the "graben" type and similar to many of the streams of the Adirondacks.

The physiographic features of the Laurentian Plateau are reproduced in miniature in the Adirondack Mountains. There also is a plateau, nearly uniform in elevation, but rising to somewhat greater heights along the northeast, east, and southeast borders.[2] The plateau is apparently an uplifted peneplain. The rougher margins may have been base-leveled at the same time as the remainder, but if so all traces of the old erosion surface have been effaced in subsequent changes.

The drainage of the eastern Adirondacks is remarkably like that of the southeastern and eastern borders of the plateau proper. Many of the streams and lakes lie in steep-walled gorges or chasms. Escarpments produced by the compounding of several fault systems are also suggestive of the scarp along the border of the Laurentide Mountains.

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[1] E. M. Kindle and L. D. Burling, *Geol. Survey Canada Mus., Bull. 18.*

[2] W. J. Miller, *N.Y. State Mus., Bull. 164*, p. 81.

The remainder of the Adirondack region, the western half or plateau portion, "is not absolutely flat, but is more or less diversified with low hills and intervening broad valleys. Occasional summits give views of moderate extent, but no elevations can properly be called mountains, and the general term plateau is most expressive."[1]

In the Superior Highlands of northern Wisconsin, northwestern Michigan, and northern Minnesota there is another area topographically similar to the Laurentian Plateau proper.

> Like the latter its sky line is distinctly even and gives little hint of the mountainous structure that prevails almost everywhere within it. Its principal topographic feature is an uplifted and dissected plain of erosion which has been glaciated and hence has many secondary features due to ice erosion. It lies neither in the region of pronounced glacial aggradation nor in that of intense glacial denudation; hence those forms that are of glacial origin are due in some cases to ice scour, in others to ice accumulation. A certain amount of glacial detritus occurs here and there; in other places the surface is swept practically clean by glacial erosion. The glacial material is irregularly disposed in characteristic fashion and blocks the drainage to such an extent that ponds and lakes occur in large numbers.[2]

The Laurentian Plateau with its outliers or spurs is an ancient peneplain which has undergone differential elevation, has been denuded, subsequently dissected around the margins, and extensively glaciated. Further than this little may be said regarding its physiographic history. It is fairly well established that a peneplain was developed in pre-Cambrian time over the main part of the plateau, including the Adirondacks and probably the Superior Highlands. There is some evidence of a second peneplain developed upon Paleozoic sediments. Owing to the almost complete removal of these sediments and their existence at present only in small down-faulted blocks, the fact of this peneplain is not fully established. There is unquestionable evidence of a third, probably Cretaceous, peneplain produced over the greater part of the plateau, including the Adirondacks and possibly the Superior Highlands. However, in the present state of our knowledge, sweeping generalizations regarding the number, dates, or extent of the several peneplains are not justifiable.

[1] J. F. Kemp, *Pop. Sci. Mon.*, LXVIII, 199.

[2] Isaiah Bowman, *Forest Physiography*, pp. 572, 573.

THE ST. LAWRENCE VALLEY PROVINCE

The St. Lawrence Valley, bordered on one side by the New England region and on the other by the Laurentian Plateau, is a strip of territory sufficiently different in structure, topography, and physiographic history to require separate discussion. This is known to Canadian geologists as the St. Lawrence Lowlands. This name is perhaps better suited to designate the province than St. Lawrence Valley as the province has a greater extent than the mere valley of the river.

> Commencing near the city of Quebec, these lowlands stretch on both sides of the St. Lawrence River, southwestward, with slightly diverging boundaries until at Montreal the level country is approximately 120 miles wide. Beyond Montreal the northern boundary pursues a westward course up the Ottawa Valley to a point about 50 miles beyond Ottawa city, where a ridge of broken country, a low spur of the Laurentian Highlands, projects southward, crossing the St. Lawrence between Brockville and Kingston to join the elevated Adirondack region of northern New York.[1]

Young extends the province beyond this spur and includes the territory of the Ontario Peninsula "lying between Lakes Huron, Erie, and Ontario, and bounded on the north by a nearly east-west line from Kingston to the foot of Georgian Bay." In this paper this territory has been included in the Lake section, and the Laurentian spur should probably be regarded as the natural boundary of the lowlands. This opinion is supported by Kindle and Burling, who write that "the Paleozoic plain of the Ottawa and St. Lawrence valleys lies between the Laurentian Plateau on the North and the Adirondack uplift on the South, and extends eastward from the Archean shield at the head of the St. Lawrence to the zone of Appalachian folding east and southeast of Montreal."[2]

Branching off to the south from this province near Montreal is the Champlain-Hudson Valley, which is topographically similar to the St. Lawrence Valley and which may be regarded as a section of the province.

The main division of the province, that which embraces the valley of the St. Lawrence River, is a plain floored with Paleozoic rocks. Its elevation is but a few hundred feet above sea-level, and there are only occasional departures either upward or downward from the general level. It lies beneath the limiting provinces and is cut off from two of them by faults—the St. Lawrence-Champlain fault separating it from the New England region,[1] and the Laurentian Plateau fault marking its northern boundary.[2]

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[1] C. A. Young, *op. cit.*, p. 60.

[2] E. M. Kindle and L. D. Burling, *op. cit.*, p. 9.

Of the few eminences rising above this plain, the Monteregian Hills are the most prominent. These hills are eight in number. They extend along an east-west line about ten miles apart, and rise abruptly from 600 to 1,200 feet above the surrounding country. Structurally they are cores of igneous rocks (probably conduits emanating from a dike or laccolith) surrounded and mantled by sediments in such a manner as to indicate that at the time of their intrusion the overlying Paleozoic strata were many hundreds of feet thicker than at present. This great mantle of rock has been since removed by erosion, except where local down-faulting has preserved remnants of it. Recent work on the Laurentian Plateau has discovered several outliers of Paleozoic rock scattered over its surface which were preserved in this manner.

A variable thickness of glacial material which was assorted by the Pleistocene or post-Pleistocene marine invasion is spread upon the Paleozoic bedrock. Upon this in turn lies a thin veneer of marine sediments. The earlier erosion topography is probably neither accentuated nor subdued in any marked degree by the drift and sediments.

The Champlain-Hudson Valley resembles the St. Lawrence Valley in several respects, namely, it lies at approximately the same altitude above sea-level; it is a low plain lying between adjacent mountainous provinces; it is floored with Paleozoic rocks; it has a mantle of drift spread over an old erosion surface; and it was subjected to a postglacial marine invasion. A part of this valley is occupied at present by the waters of Lake Champlain and Hudson River.

In the St. Lawrence Valley physiographic history begins with the emergence of the Paleozoic rocks with which it is floored. The time of this emergence is uncertain, but post-Devonian at all events, as deposits containing Devonian fossils have been found in places. These sediments were probably 5,000 feet thick over the province at the time of the emergence, and no doubt they also covered a part of the Laurentian Plateau and the Adirondack Mountains.

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[1] C. A. Young, *op. cit.*, p. 62.

[2] E. M. Kindle and L. D. Burling, *op. cit.*, Fig. 5.

From the time of the emergence until the Pleistocene epoch erosion appears to have been uninterrupted, and the region was denuded of 2,000 to 3,000 feet of rock. This almost completely uncovered the pre-Cambrian rocks of the plateau, and would have exposed the pre-Cambrian in the St. Lawrence Valley had not down-faulting on a large scale preserved a variable thickness of the sedimentaries.[1]

During or immediately preceding the Pleistocene epoch there was a widespread downwarping of central and eastern Canada, which caused the former southward-flowing streams to change their direction of flow to the north. As the ice retreated, some of the water found an outlet to the sea via the St. Lawrence River and distributed along its course a considerable amount of glacial débris. When the ice had retreated far enough, the sea advanced up the St. Lawrence Valley, assorted the glacial material by wave-action, and deposited upon it a thin bed of marine formation. With the final disappearance of the ice there was a general elevation of the north country, and marine beds are now found in certain places at elevations exceeding 600 feet.[2]

The Champlain-Hudson Valley was the scene of a similar sequence of events, as witness the character of the bedrock on the valley floor, the assorted glacial debris, and the postglacial marine beaches standing 300 or more feet above sea-level.[3]

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[1] E. M. Kindle and L. D. Burling, *op. cit.*, p. 20.

[2] J. W. Goldthwait, *Geol. Survey Canada, Guide Book, No. 3*, pp. 118–26.

[3] W. J. Miller, *N.Y. State Mus., Bull. 168.*